Simulation for B-meson Tagging via Non-Prompt D^0's with sPHENIX

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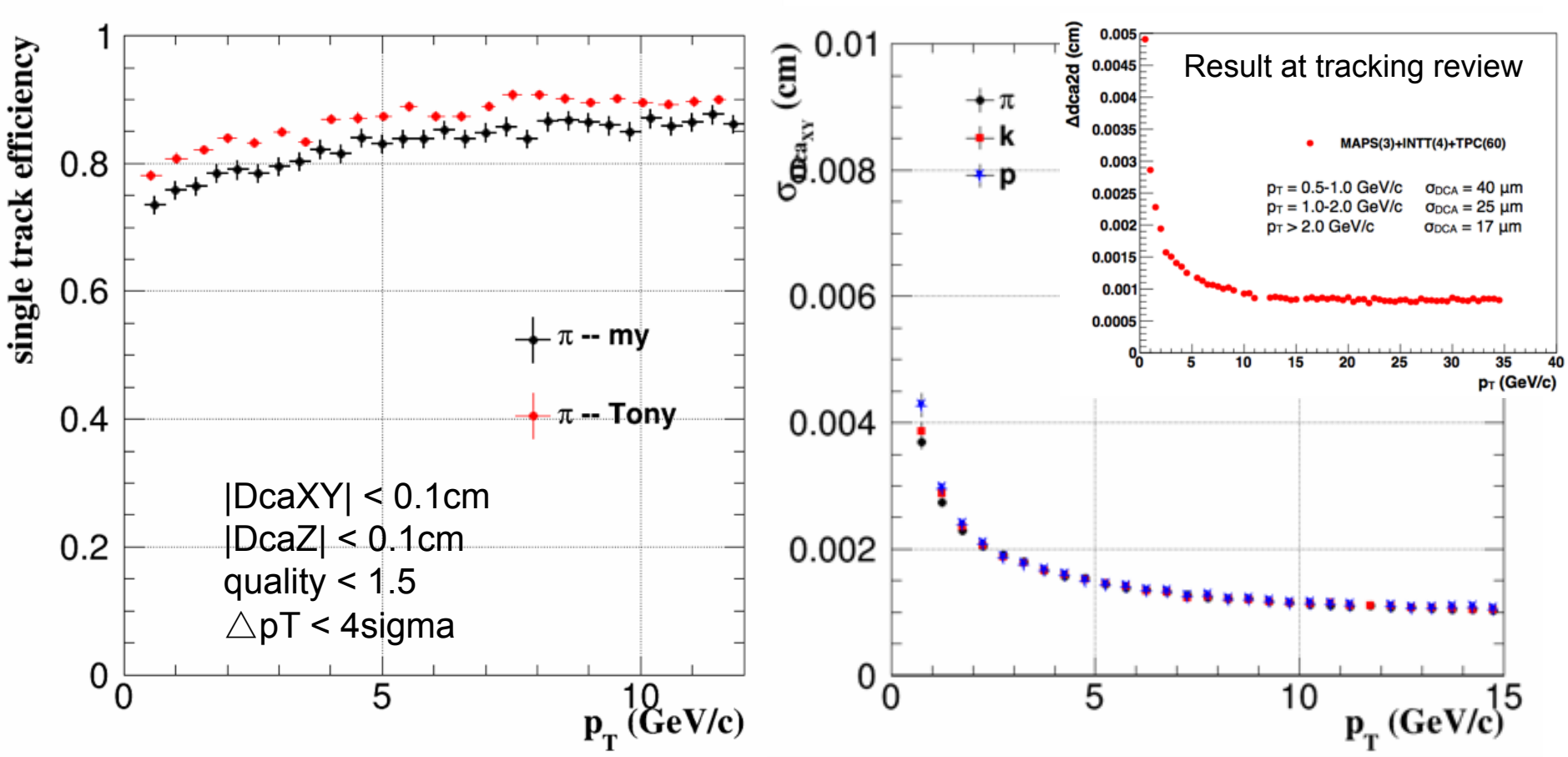
The approach: Full GEANT simulation + fast MC

- Full GEANT simulation to provide input on efficiency, DCA distributions
- Fast MC to estimate reconstructed signal and background rate
- Convert to physics observables

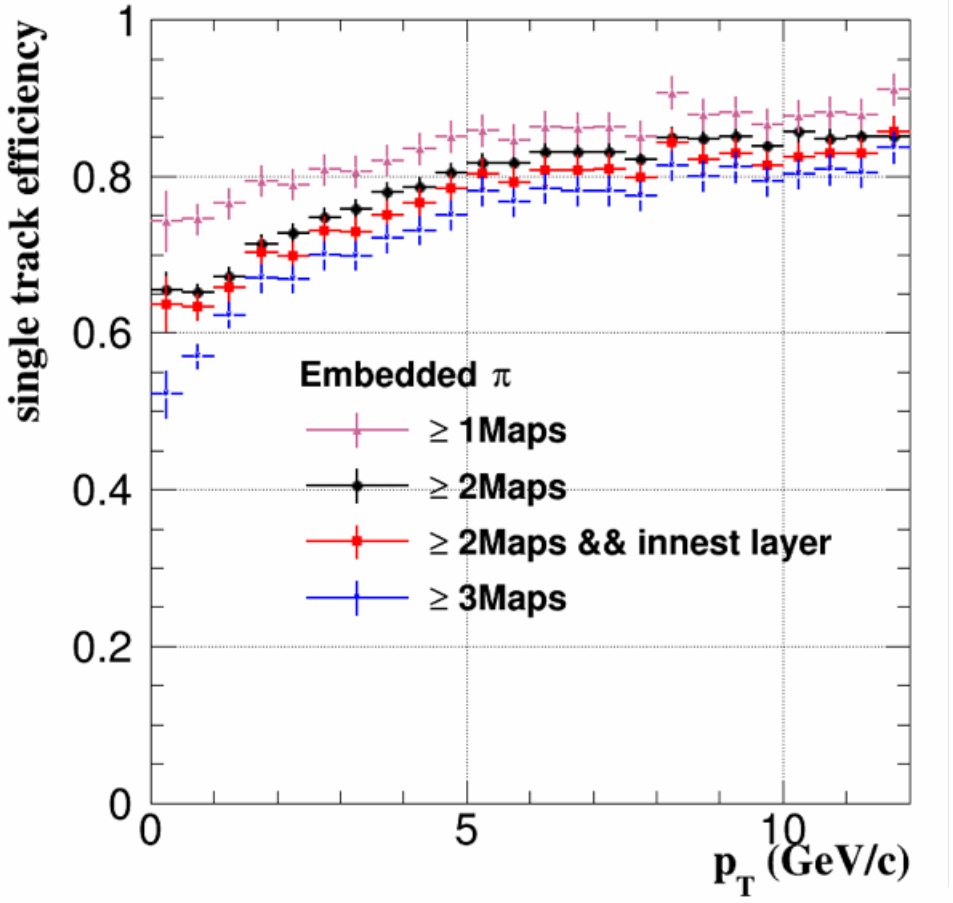
Full GEANT Simulation

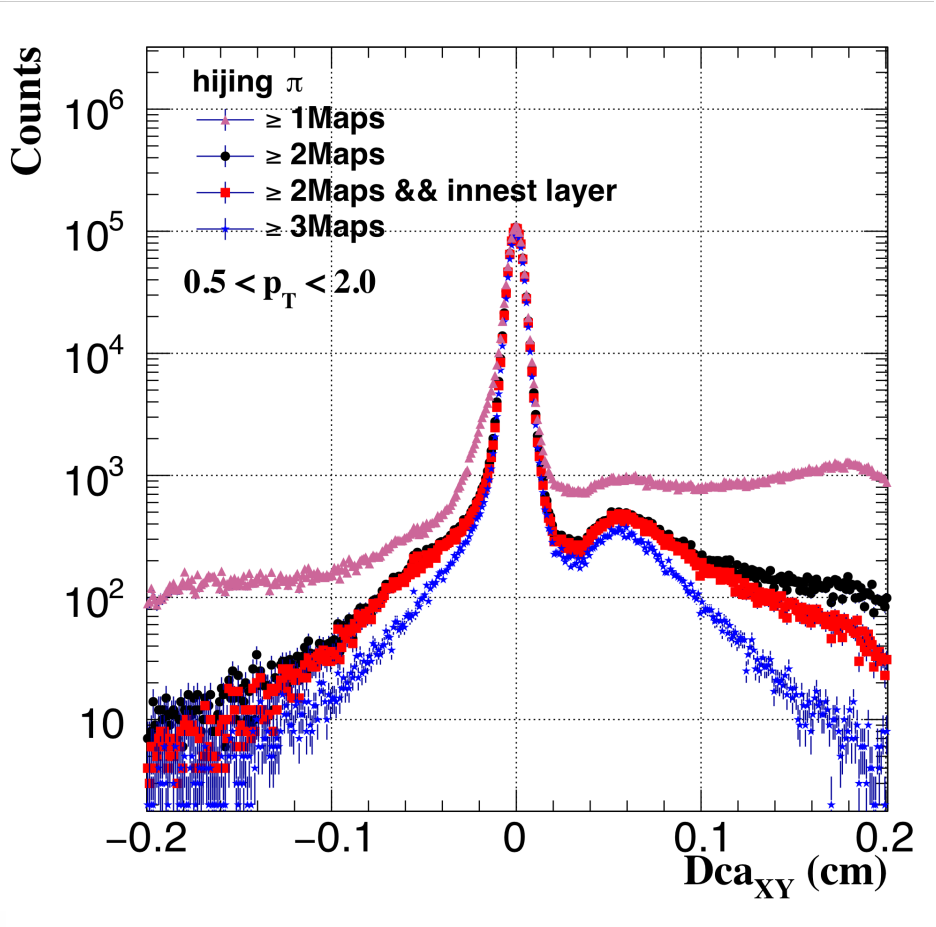
Central 0-10% Hijing events + 30 embedded pi/K/p tracks each with the latest production configuration



Reasonable agreement with performance shown at tracking review, despite some detail difference to be sorted out.

Look into the MAPS Hit Pattern





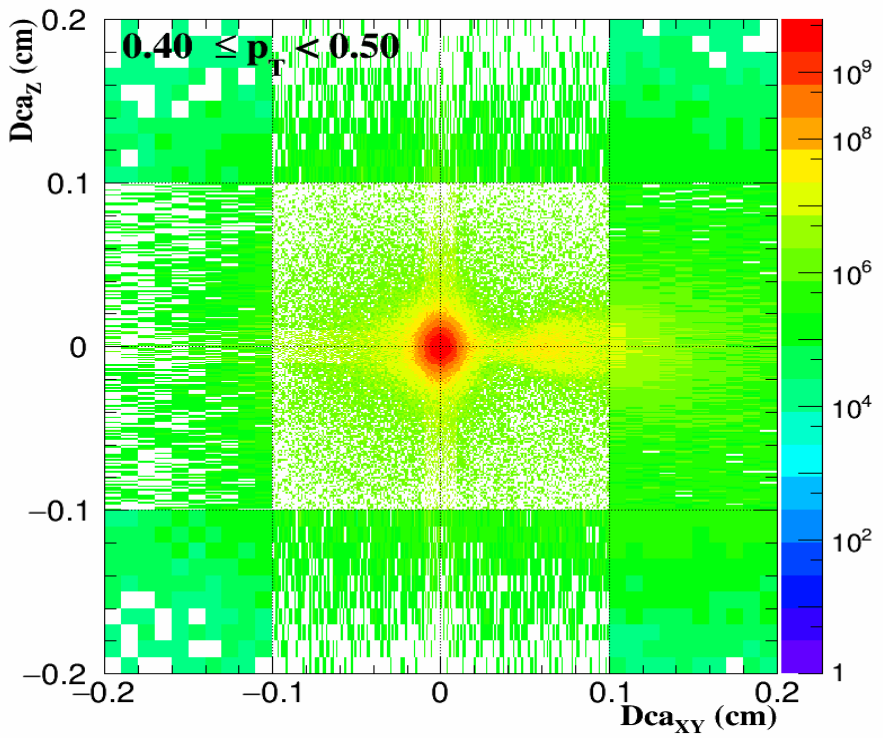
Fast Simu Procedure

Fast simulation package:

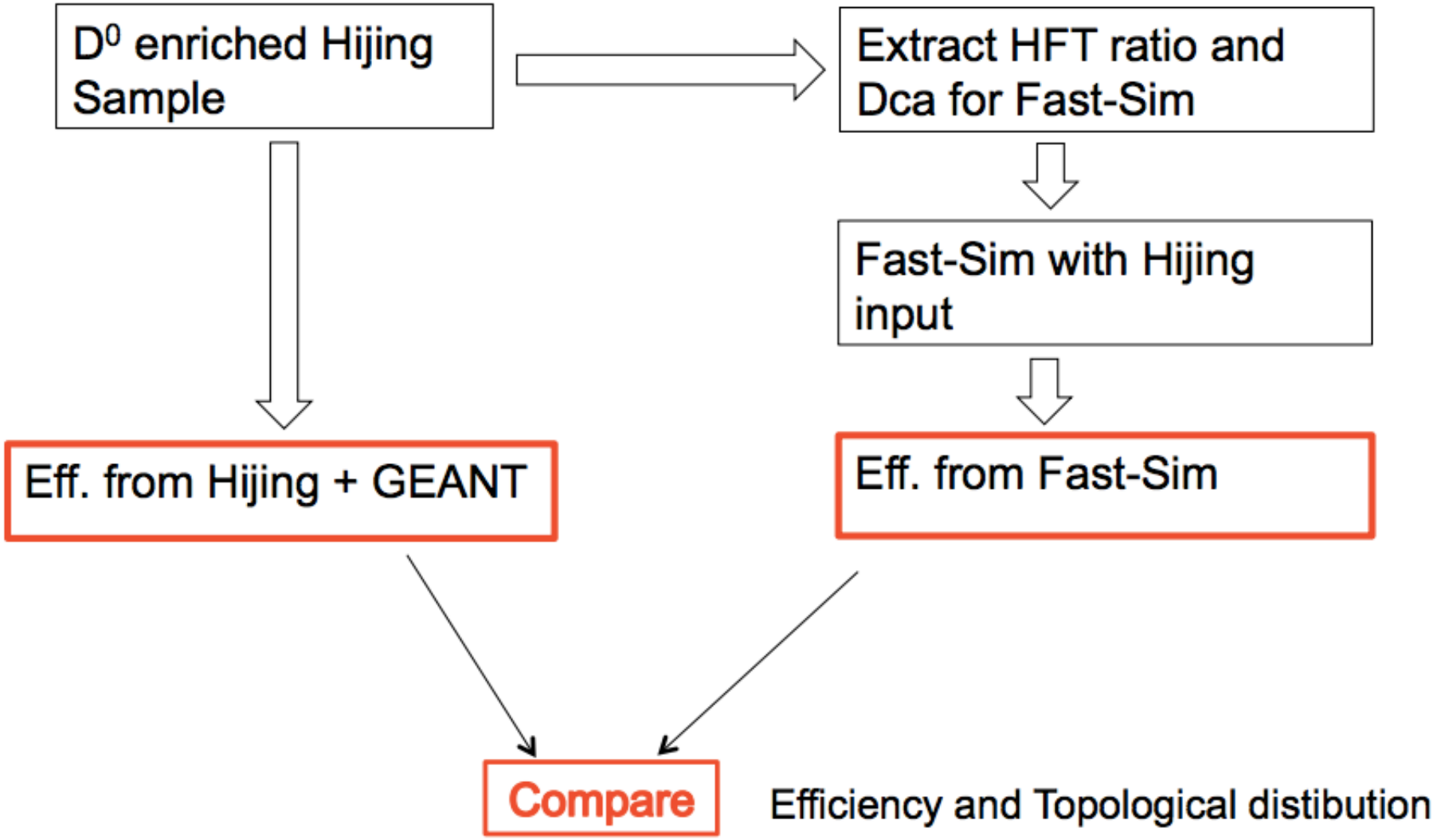
1) Sample event vtx distributions
2) Throw signal (D0, B) or background (pi,K,p from Hijing) tracks, decay if needed
3) Smear the track origin with (DCAxy, DCAz) 2D distributions
4) Smear the momentum according to the momentum resolution
5) Full reconstructed helices -> reconstruct secondary vertex
6) Calculate the signal efficiency or background accept-rate

Based on the package originally developed for STAR HFT efficiency calculation (data-driven).

Key input, (DCAxy, DCAz) 2D distributions

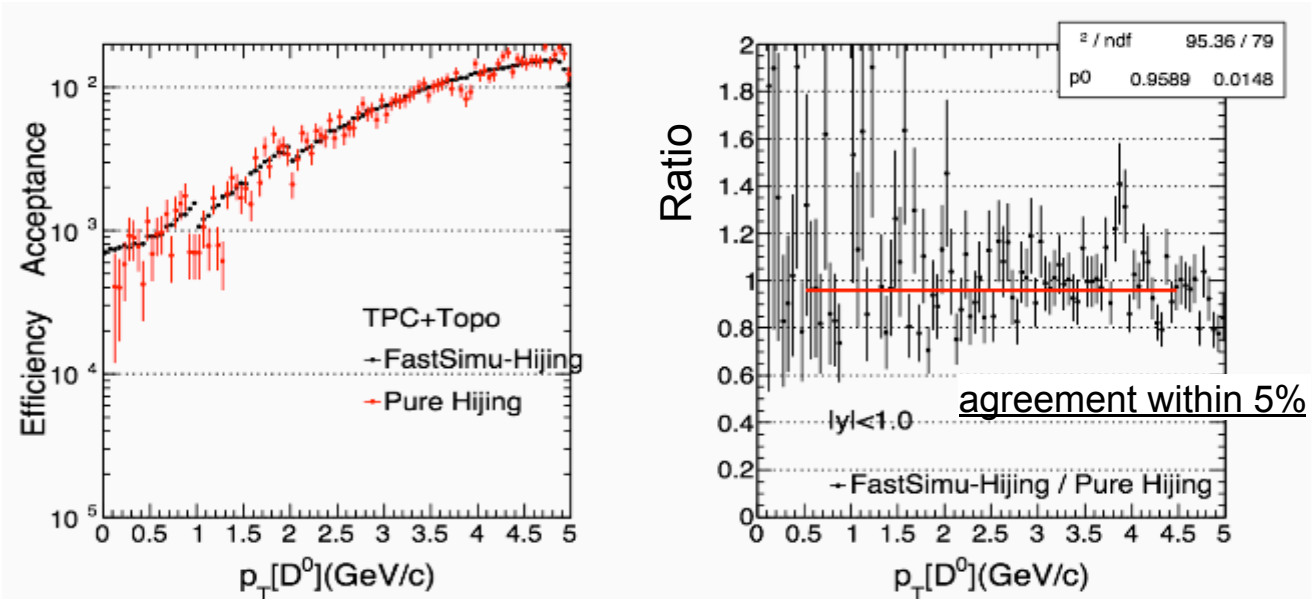


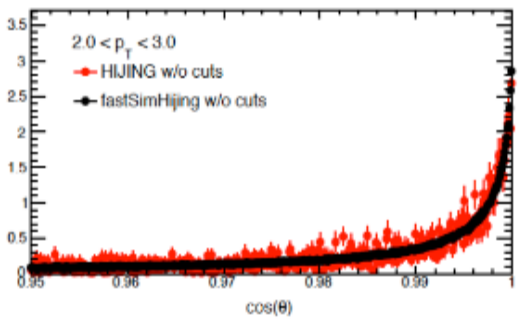
Validation of Signal Eff. with Full GEANT Simulation

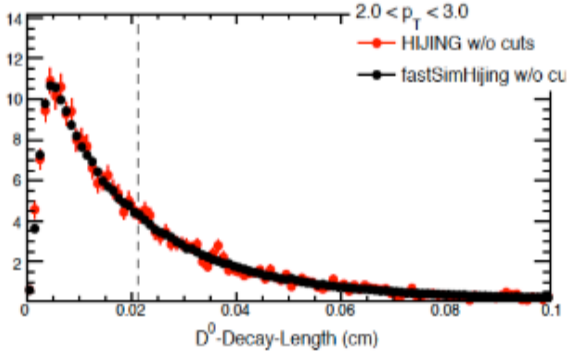


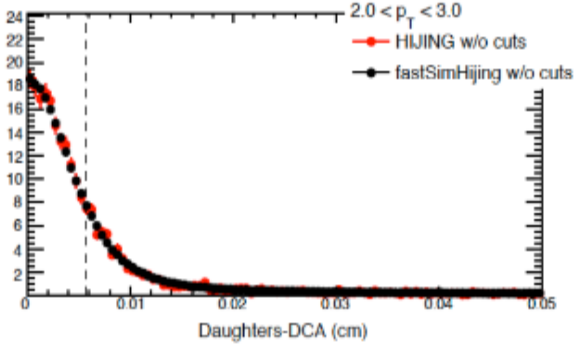
Validation of Signal Eff. with Full GEANT Simulation

- Hijing+D^0 sample through GEANT + reconstruction
- Fast simu – inputs taken from Hijing single track performance
- Then compare the efficiencies between fast simu vs. that from Hijing+GEANT directly

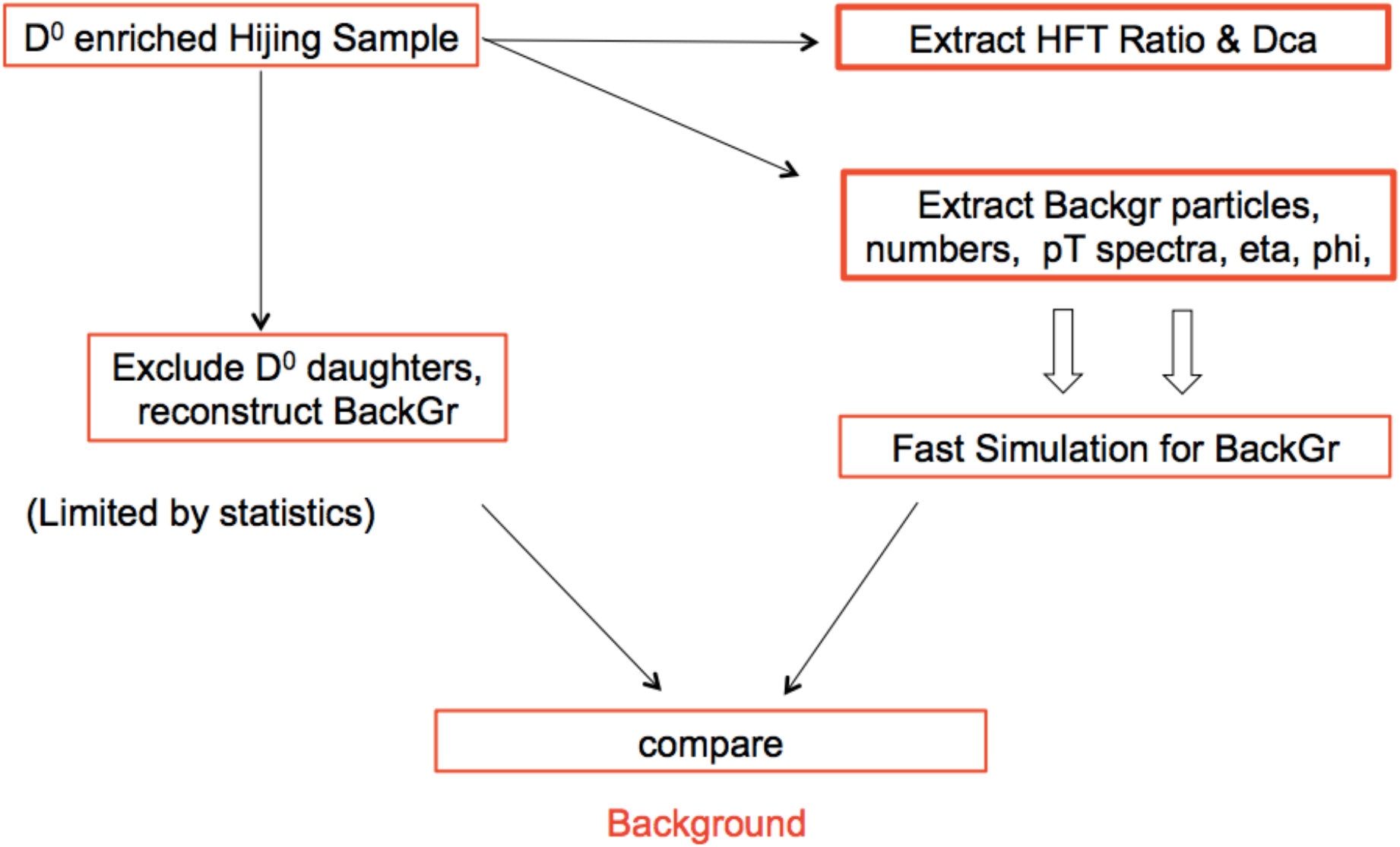




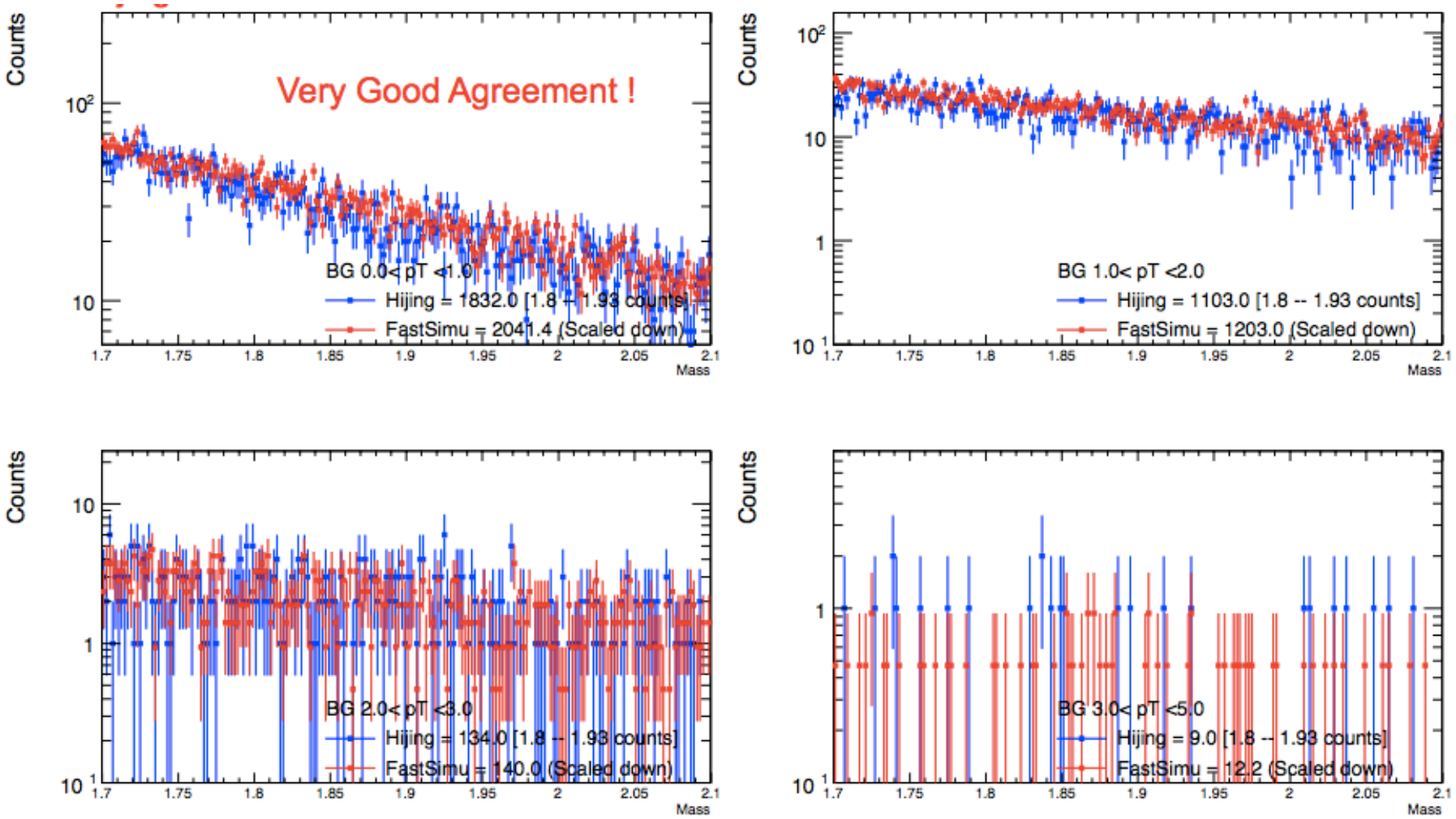




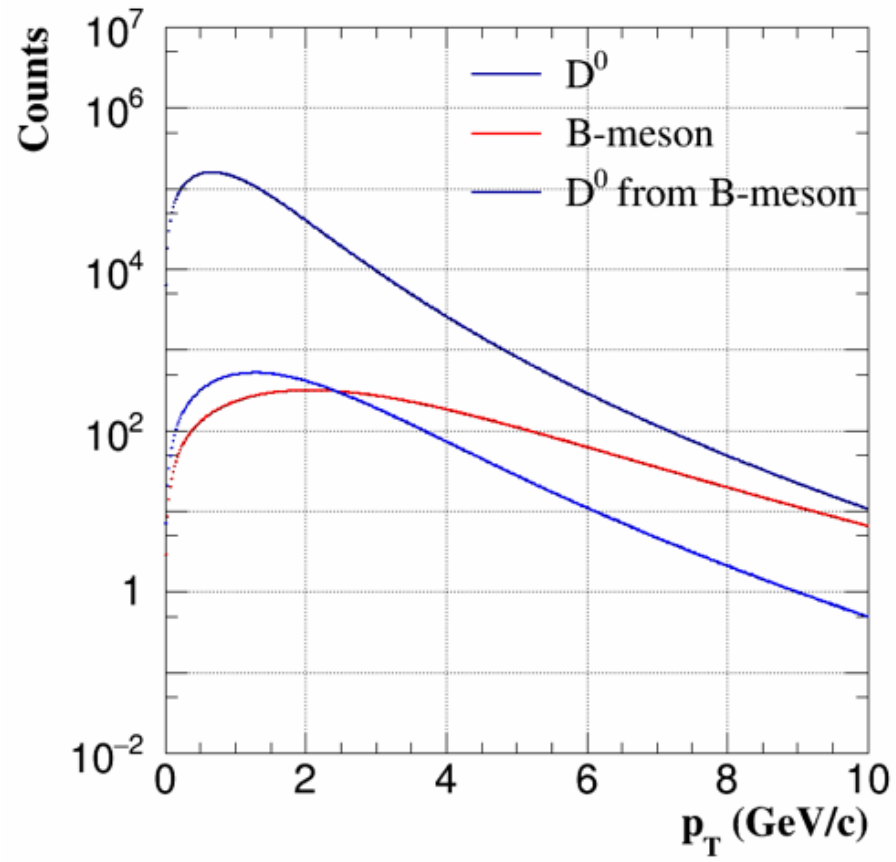
Validation of Bkgd with Full GEANT Simulation



Validation of Bkgd with Full GEANT Simulation



Bottom Input based on pQCD FONLL

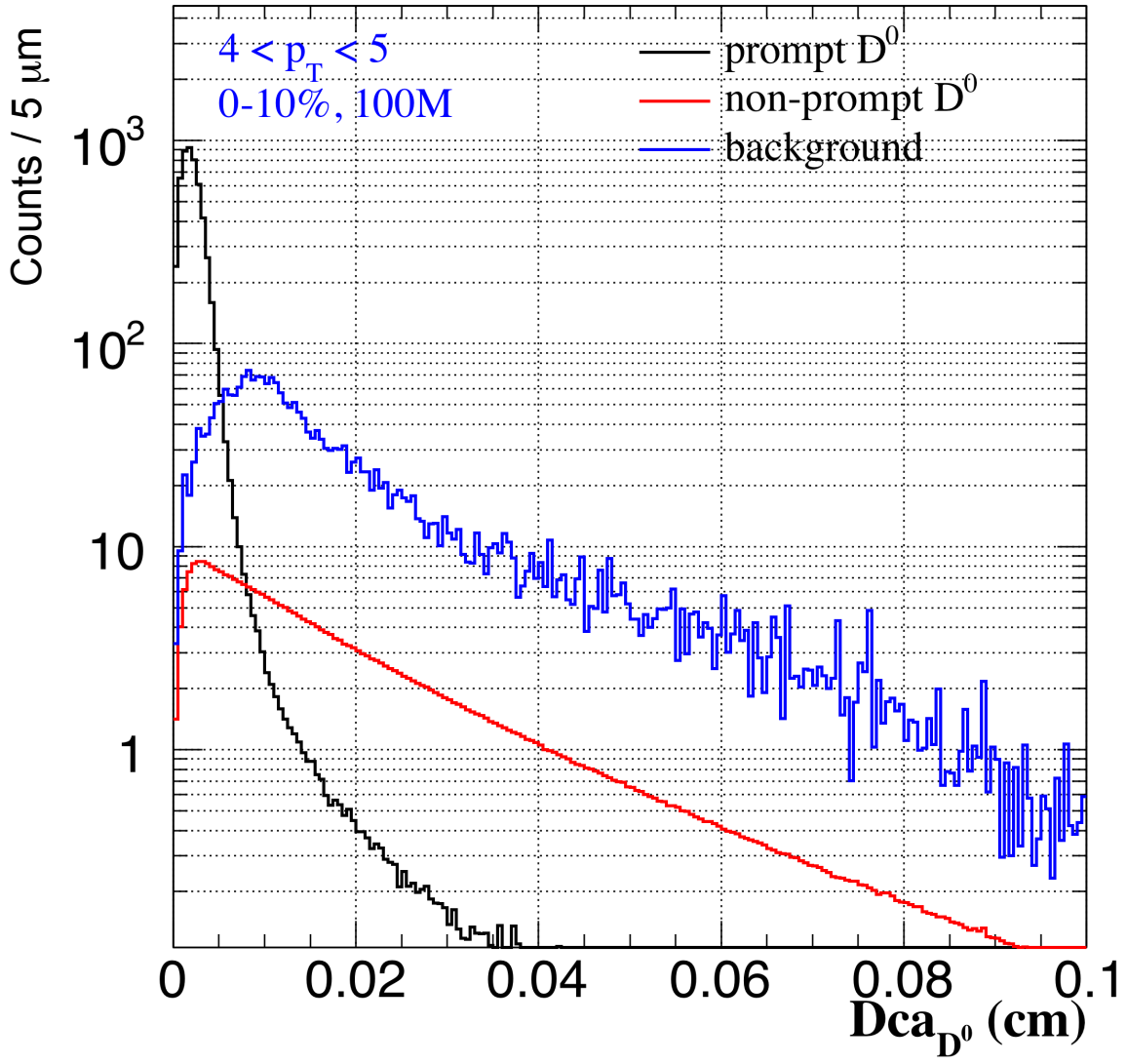


B-meson decay using PYTHIA
Scaled to the BR. according to PDG

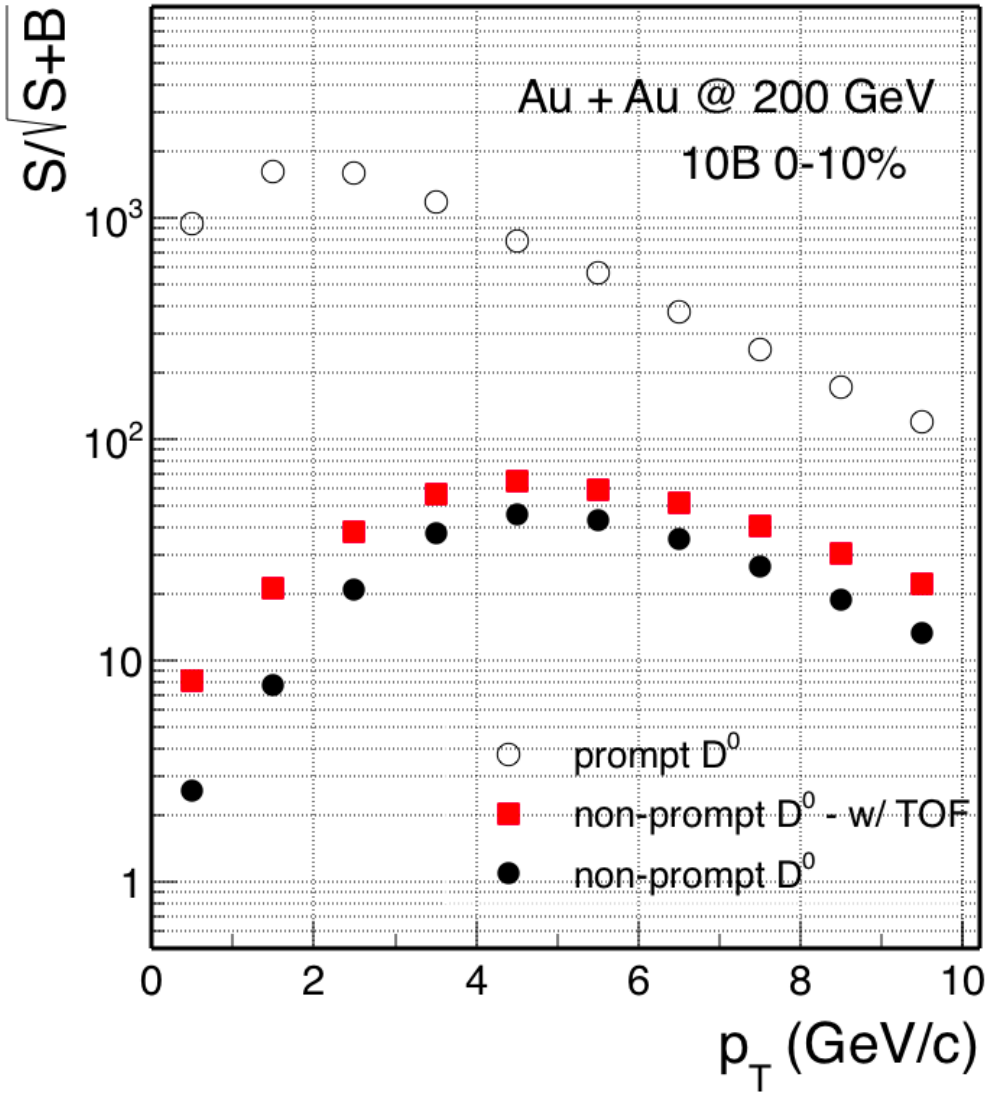
Default:
FONLL*Nbin for AuAu
In physics performance plot RAA/RCP,
RAA is applied in addition for signal

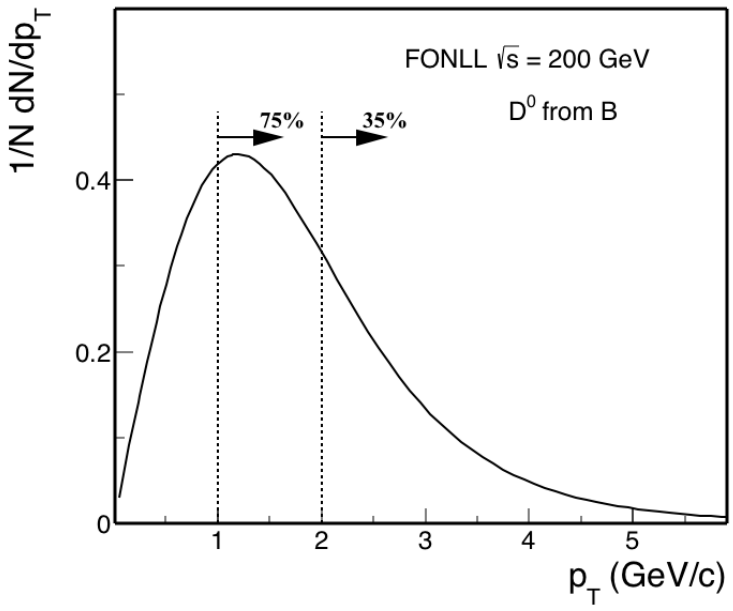
Particle	$c\tau(\mu m)$	Mass(GeV/c^2)	$q(c,b) \rightarrow X(FR)$	$X \rightarrow D^0(\overline{D^0})$ (BR)
D^0	123	1.865	0.565	-
B^0	459	5.279	0.40	0.081(0.474)
B^+	491	5.279	0.40	0.086(0.790)

Reconstructed D^0 DCA Distributions



Estimation on Non-prompt D^0 Significance

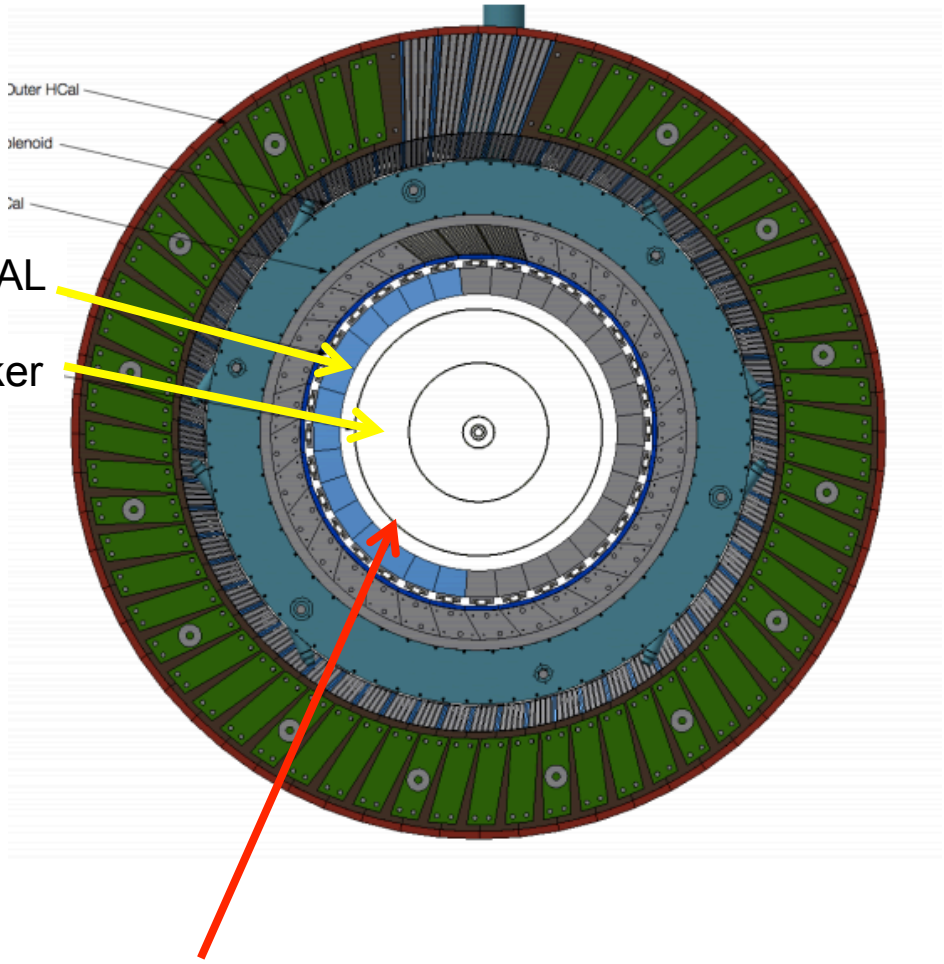




Good performance for measuring non-prompt D^0 at low p_T with sPHENIX

PID detector (TOF) can help further improve particularly the low p_T precision
- constrain the total bbbar X-sec

Particle Identification with TOF



10cm gap between TPC and EMCAL - TOF

TOF PID requirement:

$$M = p\sqrt{\left(\frac{ct}{L}\right)^2 - 1}$$

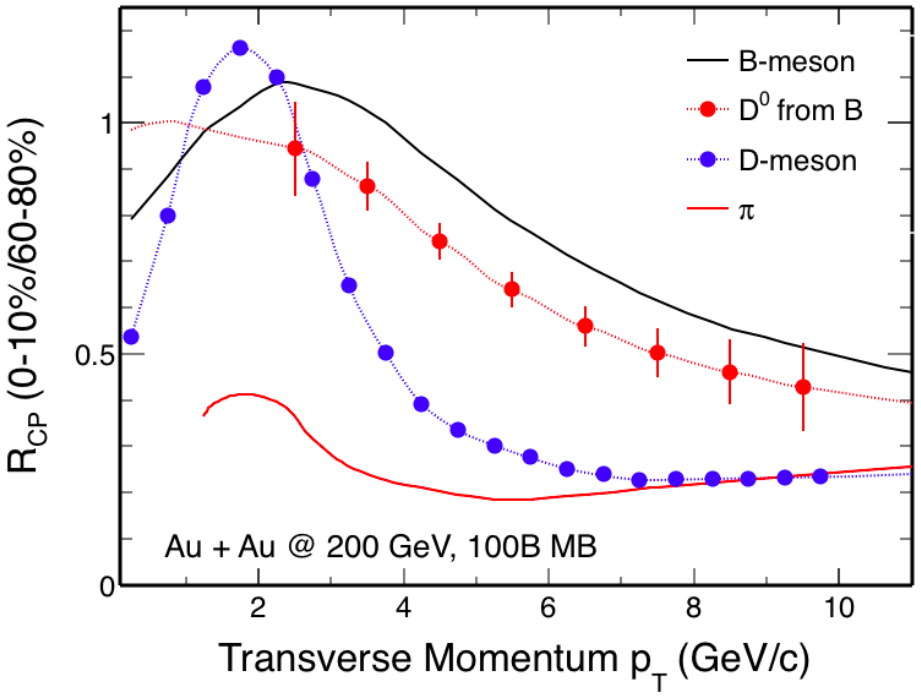
$$\frac{\Delta M}{M} = \frac{\Delta p}{p} \oplus \gamma^2 \left[\frac{\Delta L}{L} \oplus \frac{\Delta t}{t}\right] \sim \gamma^2 \frac{\Delta t}{t}$$

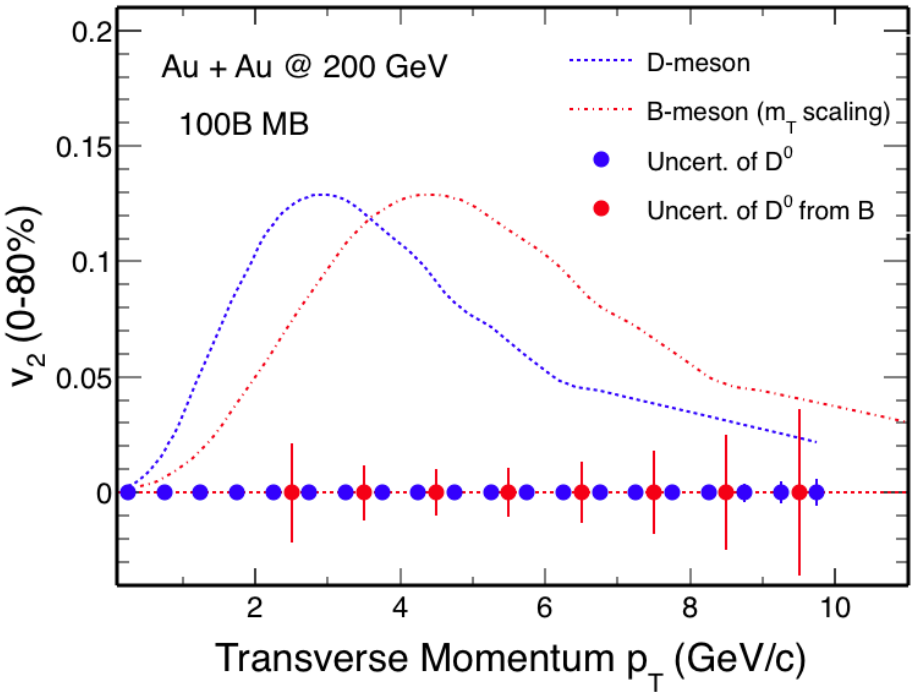
STAR TOF:
Radius ~ 2.15 m, σ_t ~ 65 ps

sPHENIX TOF
(to have the same PID capability)
Radius ~ 0.85 m, **σ_t ~ 25 ps**

Simplified PID assumed:
Clean pi/K PID at pT<1.6 GeV
No pi/K PID at pT>1.6 GeV

R_{CP} and v_2 Projections for Non-Prompt D^0





R_{CP} theory curves: average R_{AA} of calculations from Duke, TAMU and CUJET
v_2 of D-meson: fit to STAR HFT D^0 data points

Assuming: Signal scales with N_{bin}, background scales with N_{part}^2